WE CLAIM AS OUR INVENTION

1. A compact, hydrogen generator comprising a reformer for converting a fuel and either steam or steam and oxygen into a reformate containing hydrogen and carbon oxides; a downstream shift reactor for converting carbon monoxide in the reformate with water to carbon dioxide and hydrogen, said shift reactor having at least one catalyst stage; a conduit from the reformer and encompassing the shift reactor for passing the reformate from the reformer through the shift reactor; and a heat exchanger/distributor within the conduit for cooling the reformate, said heat exchanger/distributor comprising:

   (a) an indirect heat exchanger adapted to received liquid water and having sufficient surface area to vaporize the received water to steam and adapted to cool the reformate in the conduit,

   (b) at least one separator in fluid communication with the indirect heat exchanger adapted to receive steam from the indirect heat exchanger and remove substantially all liquid water, and

   (c) at least one steam distributor in fluid communication with the separator to pass the steam into the reformate.

2. The hydrogen generator of claim 1 in which the generator further comprises an indirect heat exchanger adapted for heat exchange with reformate in the conduit.

3. The hydrogen generator of claim 2 in which the indirect heat exchanger is positioned upstream of the heat exchanger/distributor.

4. The hydrogen generator of claim 1 in which the at least one separator is a riser.

5. The hydrogen generator of claim 1 in which the heat exchanger/distributor comprises at least 4 distributors.

6. The hydrogen generator of claim 1 in which the heat exchanger/distributor is located between the reformer and the water gas shift reactor.

7. The hydrogen generator of claim 1 in which the water gas shift reactor comprises at least two catalyst stages and the heat exchanger/distributor is located between two catalyst stages.

8. A process for using water to cool reformate from a reformer for the conversion of fuel and either steam or steam and oxygen to hydrogen and carbon oxides comprising subjecting the reformate to indirect heat exchange with liquid water, said water being provided at a rate sufficient to cool the reformate while being substantially completely converted to steam; separating the steam from the liquid water; and passing the separated steam into the reformate.

9. The process of claim 8 wherein the process further comprises subjecting the reformate to water gas shift conditions in the presence of steam to provide a reformate having a reduced carbon monoxide content, and the cooling occurs prior to subjecting the reformate to water gas shift conditions.

10. The process of claim 9 wherein the cooling with water reduces the temperature of the reformate to water gas shift conditions.

11. The process of claim 10 wherein the water gas shift conditions comprise a temperature between about 320°C to 450°C.

12. The process of claim 8 wherein the process further comprises subjecting the reformate to water gas shift conditions in the presence of steam, said conditions comprising the use of at least two catalyst zones, and the cooling occurs between two catalyst zones.

13. The process of claim 12 wherein the water gas shift conditions for the catalyst zone after the cooling comprise a temperature of between about 180°C and 300°C.

14. A process for generating hydrogen comprising:

(a) reforming a fuel under reforming conditions including the presence of steam and optionally oxygen to produce a reformate containing hydrogen and carbon monoxide and carbon dioxide and having a temperature of at least about 600°C; and

(b) subjecting the cooled reformate to water gas shift conditions comprising a temperature of less than about 450°C to produce a reformate having a reduced carbon monoxide content,

(c) wherein reformate is cooled with liquid water by subjecting the reformate to indirect heat exchange with liquid water, said water being provided at a rate sufficient to cool the reformate while being substantially completely converted to steam; separating the steam from the liquid water; and passing the separated steam into the reformate.

15. The process of claim 14 wherein the reformate prior to being subjected to water gas shift conditions is cooled by indirect heat exchange with a stream comprising the fuel for the reforming step.

16. The process of claim 14 wherein the cooling with water reduces the temperature of the reformate to water gas shift conditions.

17. The process of claim 16 wherein the water gas shift conditions comprise a temperature between about 320°C to 450°C.

18. The process of claim 14 wherein the water gas shift comprises at least two catalyst zones, and the cooling occurs between two catalyst zones.

19. The process of claim 18 wherein the water gas shift conditions for the catalyst zone after the cooling comprise a temperature of between about 180°C and 300°C.

20. The process of claim 14 wherein the reforming is an autothermal reforming of fuel with steam and oxygen.